

WE CLAIM:

1. A system for the spray forming manufacture of near net shape molds, dies
and related toolings, comprising:

3 a nozzle having a flow channel, said flow channel having an inlet end, an outlet
4 end and a longitudinal axis;

5 a liquid reservoir in fluid communication with said nozzle flow channel, said
6 reservoir containing a liquid material capable of forming a mold, said liquid being
7 pressurized in a pressurized reservoir and injected from said reservoir through a conduit
8 ending in said nozzle flow channel between said inlet and outlet ends and proximate to
9 said nozzle longitudinal axis;

10 means for flowing a high temperature atomizing gas at a flow velocity ranging
11 from high subsonic through supersonic velocities through the nozzle flow channel from
12 the inlet end to the outlet end to atomize the liquid injected into the flow channel into a
13 plume of atomized droplets directed to a chamber containing a quench gas, said quench
14 gas having a controlled temperature and composition for controlling the in-flight cooling
15 of the atomized droplets;

16 means for directing and depositing the cooled atomized droplets onto a pattern to
17 form the mold.

2. The system of claim 1 wherein said quench gas is selected from a group
consisting of nitrogen, helium, argon, oxygen, air, and combinations thereof.

3 3. The system of claim 1 further comprising means for independently heating the
nozzle and reservoir.

4 4. The system of claim 1 further comprising means for providing relative
movement between nozzle and the pattern.

1 5. The system of claim 1 wherein a plurality of liquid materials capable of
2 forming a mold are injected separately into the nozzle flow channel.

1 6. The system of claim 1 wherein the nozzle flow channel converges to a choke
2 portion located between the inlet end and the outlet end, and diverges between the choke
3 portion and the outlet end.

1 7. The system of claim 1 wherein the liquid material is injected into the nozzle
2 flow channel proximate to the longitudinal axis between the inlet end and the choke
3 portion of the flow channel.

1 8. The system of claim 1 wherein the liquid material is injected into the nozzle
2 flow channel proximate to the longitudinal axis between the choke portion and the outlet
3 end of the flow channel.

1 9. The system of claim 1 wherein the liquid material is a molten metal.

- 2 10. The system of claim 1 wherein the liquid material is a molten metal
3 containing solid particles.
- 1 11. The system of claim 10 wherein the molten metal is selected from the group
2 consisting of tin, aluminum, zinc, and copper.
- 1 12. The system of claim 1 wherein the liquid material is a molten metallic alloy.
- 1 13. The system of claim 12 wherein the molten metallic alloy is selected from the
2 group consisting of steel, bronze and brass.
- 1 14. The system of claim 1 wherein the liquid material is a polymer solution.
- 1 15. The system of claim 1 wherein the liquid material is a polymer solution
2 containing solid particles.
- 1 16. The system of claim 1 wherein the means for injecting the liquid material into
2 the nozzle flow channel is accomplished by pressurizing the liquid reservoir.
- 1 17. The system of claim 1 wherein the nozzle flow channel has a linear transverse
2 cross-sectional geometry.

1 18. A system for the spray forming manufacture of near net shape molds, dies
2 and related toolings, comprising:

3 a plurality of nozzles, each nozzle having a flow channel, each of said flow
4 channels having an inlet end, an outlet end and a longitudinal axis;

5 a liquid reservoir in fluid communication with each of said nozzle flow channels,
6 said reservoir containing a liquid material capable of forming a mold, said liquid being
7 pressurized in a pressurized reservoir and injected from said reservoir through a conduit
8 ending in said nozzle flow channel between said inlet and outlet ends and proximate to
9 said nozzle longitudinal axis;

10 a high temperature atomizing gas at a flow velocity ranging from high subsonic
11 through supersonic velocities through each of the nozzle flow channels from the inlet end
12 to the outlet end to atomize the liquid injected into the flow channels into a plume of
13 atomized droplets directed to a chamber containing a quench gas, said quench gas having
14 a controlled temperature and composition for controlling the in-flight cooling of the
15 atomized droplets;

16 means for directing and depositing the cooled atomized droplets onto a pattern to
17 form the mold.

18 19. The system of claim 18 further comprising means for independently heating
19 the nozzles and reservoirs.

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1 20. The system of claim 18 further comprising means for providing relative
movement between nozzle and the pattern.

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1 21. The system of claim 18 wherein a plurality of liquid materials capable of
2 forming a mold are injected separately into the nozzle flow channel.

1 22. The system of claim 18 wherein the nozzle flow channel converges to a choke
2 portion located between the inlet end and the outlet end, and diverges between the choke
3 portion and the outlet end.

1 23. The system of claim 22 wherein the liquid material is injected into the nozzle
2 flow channel proximate to the longitudinal axis between the inlet end and the choke
3 portion of the flow channel.

1 24. The system of claim 22 wherein the liquid material is injected into the nozzle
2 flow channel proximate to the longitudinal axis between the choke portion and the outlet
3 end of the flow channel.

1 25. The system of claim 18 wherein the liquid material is a molten metal.

1 26. The system of claim 18 wherein the liquid material is a molten metal
2 containing solid particles.

- 3 27. The system of claim 26 wherein the molten metal is selected from the group
4 consisting of tin, aluminum, zinc, and copper.
- 1 28. The system of claim 18 wherein the liquid material is a molten metallic alloy.
- 1 29. The system of claim 28 wherein the molten metallic alloy is selected from the
2 group consisting of steel, bronze and brass.
- 1 30. The system of claim 18 wherein the liquid material is a polymer solution.
- 1 31. The system of claim 18 wherein the liquid material is a polymer solution
2 containing solid particles.
- 1 32. The system of claim 18 wherein the means for injecting the liquid material
into each of the nozzle flow channels is accomplished by pressurizing the liquid reservoir.
- 1 33. The system of claim 18 wherein each of the nozzle flow channels has a linear
2 transverse cross-sectional geometry.
- 1 34. A system for the spray forming manufacture of near net shape molds, dies
2 and related toolings, comprising:

3 a nozzle having a flow channel, said flow channel having an inlet end, an outlet
4 end, and a longitudinal axis;

5 a plurality of reservoirs in separate fluid communication with said nozzle flow
6 channel, at least one of said reservoirs containing a liquid material capable of forming a
7 mold, said liquid being pressurized in a pressurized reservoir and injected from said
8 reservoir through a conduit ending in said nozzle flow channel between said inlet and
9 outlet ends and proximate to said nozzle longitudinal axis;

10 means for flowing a high temperature atomizing gas at a flow velocity ranging
11 from high subsonic through supersonic velocities through the nozzle flow channel from
12 the inlet end to the outlet end to atomize the liquid injected into the flow channel into a
13 plume of atomized droplets directed to a chamber containing a quench gas, said quench
14 gas having a controlled temperature and composition for controlling the in-flight cooling
15 of the atomized droplets;

16 means for directing and depositing the cooled atomized droplets onto a pattern to
17 form the mold.

1 35. The system of claim 34 wherein at least one of said plurality of reservoirs
2 contains solid particles, said solid particles being injected into said nozzle flow channel
3 between said inlet and outlet ends and proximate to said flow channel longitudinal axis,
4 said injected solid particles thereby mixing with the injected liquid materials and
5 codeposited onto a pattern to form the mold.

1 36. The system of claim 35 wherein the solid particles are entrained in an aerosol
2 and injected into the flow channel.

1 37. The system of claim 34 wherein said plurality of reservoirs contain disparate
2 liquid materials capable of collectively forming a mold.